

Description of a triple Sulphuret, of Lead, Antimony, and Copper, from Cornwall; with some Observations upon the various Modes of Attraction which influence the Formation of mineral Substances, and upon the different Kinds of Sulphuret of Copper. By the Count de Bournon, F.R.S. and L.S. Read December 22, 1803. [Phil. Trans. 1804, p. 30.]

The copious contents of this paper are arranged under the three following heads:—1. A description of the sulphuret of lead mentioned in the title; 2. Observations on the various modes of attraction which influence the formation of mineral substances; and 3. Observations upon the different kinds of sulphuret of copper.

1. The cupro-antimonial sulphuret of lead, described in the first part, has hitherto been found only in Cornwall; and though many specimens of it are to be met with in various collections in the kingdom, yet no writer has hitherto taken any particular notice of it, nor has it been classed by any of the late compilers of mineralogical systems. Mr. Hatchett is the first who, on a careful analysis, has ascertained it to be a triple sulphuret, in which the sulphur is combined with lead, antimony, and copper; each of these ingredients exhibiting their characters in so striking a manner as to afford, in some measure, a new example of a natural compound in the mineral kingdom.

The following are its principal characters.—It is of a dark gray colour; it has a brilliant lustre, and is very brittle; its hardness is such, that it very easily cuts calcareous spar, but is not sufficient to scratch fluor spar; it slightly marks white paper; when rubbed, it does not emit any smell; when powdered and thrown upon a hot iron, it emits a phosphorescent light; and its specific gravity is 5765. The form of its primitive crystal is a rectangular tetrahedral prism, with terminal faces perpendicular to its axis; but as no specimen has yet been discovered in which the above-mentioned form is totally destitute of secondary facets, the author enters into a minute investigation of the various modifications of this form, hoping by this means to promote essentially the knowledge of the crystalline character, so important in the study of mineralogy. These modifications are four in number, and can only be understood by inspecting the figures which are subjoined to the paper.

To these characters is added the more essential one, which is supplied by the proportions of the constituent parts of the substance. These, according to Mr. Hatchett's analysis, consist of 42·62 of lead, 24·23 of antimony, 12·80 of copper, and 17 of sulphur: 1·20 of iron was likewise yielded in the process; but this is thought to have been a mere accidental mixture. It is next observed, that all the characters in this substance indicate very plainly the mutual combination of the three sulphurets of which it is found to be composed; the whole of the external characters above described differing materially from those of either of the three sulphurets, and also from those of any metallic substance hitherto known; and the pro-

portion of sulphur obtained from it by analysis being exactly the total quantity that should be contained in the three sulphurets of which this substance consists. The specific gravity of this substance, compared with those of its ingredients, also indicates that the combination is attended with an expansion nearly proportionate to the numbers 6000:5765.

2. The author, proposing to avail himself of the opportunity afforded him by this inquiry, to enter into an investigation concerning the various ores that are produced by the combination of sulphur and copper, of the nature of which neither mineralogy nor chemistry has yet supplied us with any certain information, thinks it necessary, in the second part of his paper, to offer some remarks concerning the different modes of attraction that appear to influence the formation of mineral substances.

Two kinds of attraction have hitherto been admitted to prevail in the formation of mineral substances, viz. the attraction of *composition*, and the attraction of *aggregation*. The former, which is more generally known by the name of chemical attraction, takes place only between the most simple or primitive molecules of a substance; which, however, must be of dissimilar nature: and to its action is owing the formation of new, or, as they may properly be called, secondary or integrant molecules; because they, and they only, determine the nature of all the compound bodies belonging to the mineral kingdom. The difference existing between mineral bodies is now said to depend—1st, Upon the nature of the primitive molecules, by the combination of which they are produced; and 2ndly, Upon the proportion in which these molecules, supposing them to be the same, are combined together. The combination of these secondary molecules is effected by the attraction of aggregation, which unites them into one or several masses, perfectly homogeneous in all their parts. This attraction of aggregation seems to be susceptible of various modifications, which alter its manner of acting upon the constituent molecules. Of these, two are here mentioned:—1. The crystalline attraction of aggregation; and 2. The simple attraction of aggregation. The former always takes place between similar molecules, and is either *regular*, *irregular*, or *amorphous*. The first of these produces solid bodies, which are either constantly of the same form, or subject to certain laws of variation, which are always capable of being referred to the same primitive form. This, like all other crystalline attractions, can only take place in fluids, which, among other conditions, must be at rest when it is operating. When the fluid happens to be agitated, the crystallization will then be of the second kind, and the forms produced will be irregular: and when the agitation of the fluid is still greater, small irregular detached masses will subside, and unite together by a mode of attraction, which is here called *simple homogeneous attraction of aggregation*, of which instances are given in the granulated quartz and granulated carbonate of lime. This attraction operates at times simultaneously with the simple homogeneous attraction; and then the granulated masses, instead of

being composed of an aggregate of irregular grains, will appear to consist of small crystals of a very regular form, as may be very frequently seen in manganesian carbonate of lime. At other times, again, the molecules, instead of uniting together by the influence of the crystalline attraction of aggregation, are precipitated in a detached but confused manner; and then a simple aggregation takes place, which banishes all appearances of crystallization, and affords the aspect which has been distinguished by the name of *compact* or *earthy*.

This last, or the amorphous species of crystallization, is here described as being that kind which, though it produces no determinate form, is nevertheless the result of a regular aggregation. This is thought to depend on the peculiar form of the primitive molecules; such as, for instance, the globular, or others approaching to it. Calcedony, girasol, and pure transparent steatite, appear to owe their origin to this mode of formation. And here the author enters into a minute disquisition concerning the cause of the deception which has often taken place, and has led several experienced mineralogists to ascribe to these substances, especially the chalcedony, a certain degree of regular crystallization.

Besides these attractions between similar molecules of substances, there exists another, between such similar molecules and others which are *dissimilar*, or of a different nature. This introduces what may be called an *heterogeneous attraction of aggregation*, which is much weaker and more variable than any of the others, and produces substances which can no longer be called chemical combinations. In these, the dissimilar ingredients may, and often do, vary in proportion, according to the different circumstances under which they are formed; as, for instance, in those kinds of tremolite which have the dolomite for matrix where the carbonate of lime is in the proportion of $\frac{1}{10} \frac{8}{5}$; whereas in those kinds which have an argillaceous matrix, it is only in the proportion of $\frac{1}{3} \frac{5}{7}$.

Although these heterogeneous compounds be not attended with any changes in the chemical nature of their ingredients, yet they frequently, as has already been observed, admit of an alteration in their physical construction, and very often induce variations in such of their characters as more immediately depend upon that construction; such as, their specific gravity, their hardness, their transparency, and even (particularly in the class of stones) their colour. Hence it appears that the mineralogist cannot pay too much attention to this mode of attraction; since, by a due application of it, he will be enabled to understand the accidental causes of the variations to which those substances are liable. Nor should the chemist be less mindful of such an agent; since, by neglecting that precaution, he will be constantly exposed to confound those products which really belong to the chemical composition of the substances which he examines with those which are foreign to it.

At the close of this part of the paper, the author acknowledges that the different kinds of attraction here described may be nothing

more than simple modifications of one and the same power, originally belonging to matter ; but he maintains, at the same time, that these modifications certainly exert as much force, at the time of their operation, as could be exerted by attractive forces that are really different.

In the third part, which treats of the different kinds of sulphuret of copper, we are first apprised of the importance of this inquiry, by the observation, that, on comparing the different characters of this substance with those of the triple sulphuret described in the first part of this paper, we shall find that the antimony and the lead, which have been generally considered as constituent parts of the last-mentioned ore, are, in fact, nothing more than accidental ingredients, introduced merely by the attraction of aggregation.

In the sequel of the paper, the author introduces an ample stock of observations and analyses respecting various cupro-sulphurets, which have been hitherto very imperfectly examined. And first he treats of the gray tetrahedral sulphuret of copper, which is found to consist of copper, iron, and sulphur, in different proportions ; the gray copper ore, called *Fahlerz* by the Germans, being of the same composition. The yellow copper ore, or *Kupferkies* of the Germans, appears to be double sulphuret of copper and iron, but constituting a species distinct from the gray sulphuret of the same tetrahedral form. Among these, there is one in particular which has not yet been described as belonging to this ore ; namely, the dodecahedron with rhombic planes, which has hitherto been found only in Cornwall, and there only in small quantities, though in crystals of considerable size. It is also shown at length wherein most of the characters of the tetrahedral yellow cupro-martial sulphuret differ from those of the octahedral sulphuret of iron.

The following question is next proposed, and strongly recommended to the future investigation of mineralogists. As the true sulphuret of copper and the *fahlerz* are of a blackish gray colour, how comes it that the kind of cupro-martial sulphuret, commonly called pyritical copper, has always that brilliant yellow colour which particularly characterizes it, and which is the principal cause that leads many mineralogists to consider it as being nothing more than a martial pyrites mixed with copper ? The solution of this difficulty, we are told, will materially contribute to ascertain the external characters of this kind of sulphurets.

The cupro-martial sulphuret, called by Werner *Buntkupfererz*, is a new species of this ore, which crystallizes in forms that are peculiar to it, and not at all analogous to those of the other cupro-martial sulphuret. The ingredients, which are solely copper, iron, and sulphur, differ considerably in their proportions in different specimens.

The author desires that what he has here said may be considered merely as a cursory account of some of the sulphurets of copper, from which, however, he thinks it may be inferred, that there exists a great number of species of this substance which have not yet been de-

scribed, and that many of those with which we are acquainted have not been sufficiently examined.

A general observation, which he tells us is founded upon long experience, is, that there exists a great variety of minerals which have the same substance, or collection of substances, for their basis, and are combined with the same modifying substance, but whose differences arise merely from the variety of proportions in these bases or substances.

The paper closes with an earnest exhortation to those who cultivate mineralogy, to choose for the subjects of their experiments a variety of perfect specimens from different districts, and as much as possible from different matrices; that they make a number of comparative analyses; and that the mineralogist and the chemist mutually sanction the operations of each other in their respective departments.

Analysis of a triple Sulphuret, of Lead, Antimony, and Copper, from Cornwall. By Charles Hatchett, Esq. F.R.S. Read January 26, 1804. [*Phil. Trans.* 1804, p. 63.]

This is the analysis to which the Count de Bournon more than once refers in his elaborate account of the same mineral, lately read to the Society. We find here, in addition to the information contained in that paper, that one of the reasons why this very scarce ore has been hitherto so little attended to, is probably its great resemblance to an ore of antimony; that by all the chemical tests by which it has been tried, its constituent parts are manifestly lead, antimony, copper, and a small proportion of iron, the whole combined with sulphur; and that when the specific gravity, the external and internal colour, the fracture, the grain, and other characters here described are considered, there can be no doubt that the three first metals exist in the ore in, or nearly in, the metallic state, combined with sulphur, so as to form a triple sulphuret. The proportion of the ingredients are as given by Count de Bournon, who, in fact, took them from this paper.

Observations on the Orifices found in certain poisonous Snakes, situated between the Nostril and the Eye. By Patrick Russell, M.D. F.R.S. *With some Remarks on the Structure of those Orifices; and the Description of a Bag connected with the Eye, met with in the same Snakes.* By Everard Home, Esq. F.R.S. Read February 2, 1804. [*Phil. Trans.* 1804, p. 70.]

The orifice, which is the principal object of this paper, has been long since noticed by naturalists, who conceived it to be the external organ of hearing. Dr. Russell, in the many opportunities he has had of observing a variety of snakes, has particularly examined them with respect to this feature; and he here informs us, that he has found in the whole class (exclusive of the rattle-snake,) fifteen or